AOR DELINEATION

CTV III

Computational Modeling Results

Predictions of System Behavior

The maps (**Figure 1**) and cross-sections (**Figure 2**) show the computational modeling results and development of the CO_2 plume at different time steps. The boundaries of the CO_2 plume have been defined with a 0.01 CO_2 global mole fraction cutoff.

As shown in **Figure 1**, the CO_2 extent is largely defined by year 52 after the end of injection. The majority of CO_2 injectate remains as super-critical CO_2 with the remaining portion of the CO_2 dissolving in the formation brine over the simulated 100 years post injection.

[redacted]

Figure 1. Plume development through time: 1-year, 4-year, 6-year, 10-year, 16-year, 28-year (End of injection), 52-year post injection and 100-year post injection.

[redacted]

Figure 2. Cross-sections showing the plume development at various time steps through the project.

AoR Delineation

The AoR delineation was based on Critical pressure using the methods of Nicol et al. (2008), which is referenced in the US EPA AoR and Corrective Action Guidance. Based on pressure data available in the Mokelumne River formation in the region (Figure 3), it appears that the formation is under-pressured. Graph and data table showing this are shown in Figure 4. This is likely due to historic withdrawal from the Mokelumne River formation from regional Gas field operations in the area, and limited recharge.

[redacted]

Figure 3. Mokelumne River Formation Pressure profile and data

For the purpose of calculating the critical pressure and delineating the AoR for the project area, the aquifer was considered to be under-pressured by [redacted] psi, and the following equations were used to calculate critical pressure across the model domain :

$$\Delta P_{C,norm} = g(Z_V - Z_I)[\tfrac{\lambda-\xi}{2}(Z_V - Z_I) + \rho_{I,\lambda} - \rho_I] \qquad \text{- Eq (1)}$$

$$\Delta P_c = \Delta P_{C,norm} + \Delta P_u \qquad \text{- Eq (2)}$$

Where,

$\Delta P_{C,norm}$	-	the admissible overpressure in a normally pressured aquifer before fluid in the injection zone would flow into the USDW through a hypothetical open conduit
ΔP_c	-	the admissible overpressure in an under-pressured aquifer before fluid in the injection zone would flow into the USDW through a hypothetical open conduit
ΔP_u	-	the difference of normal pressure to actual pressure in the under-pressured aquifer, assumed [redacted] psi across the model domain
g	-	acceleration due to gravity, 9.81m/s^2
Z_V	-	Elevation of the injection zone
Z_I	-	Elevation of the base of the USDW
λ	-	density gradient in the conduit at constant injection zone brine TDS
ξ	-	density gradient in the conduit at initial condition
$\rho_{I,\lambda}$	-	Density of the injection zone brine at USDW depth
ρ_I	-	Density of the brine in the conduit at USDW depth at initial condition

An average TDS of 15,500ppm was assumed for the injection zone and an average TDS of 7,900ppm was assumed for the USDW based on Salinity calculations in the project area. Injection zone and USDW depths were based on the model grid and USDW mapping in the project area. Density and density gradients were calculated as a function of temperature and salinity using standard methods (McCutcheon et. al. 1993). Using these, the critical pressure was calculated at each grid point in the Petrel model using Equations 1 & 2 and combined with the pressure outputs from the plume simulation to delineate an AoR boundary at different timesteps. The final AoR boundary was based on the outermost threshold overpressure 14years into the injection which is when the maximum extent was seen. Figure 5 shows the AoR boundary, CO_2 plume extent, injection wells and proposed monitoring wells. 50 years after the end of injection, the pressure buildup in the reservoir dissipates to approximately zero.

[redacted]

Figure 4. Map showing location of wells with pressure data for the Mokelumne River Formation.

[redacted]

Figure 5: Map showing the location of injection wells and plume monitoring wells.